**EXPERIMENT REQUEST FORM** 

### BASIC INFORMATION:

|  |  |
| --- | --- |
| EXPERIMENT NAME: | SOCIALCON |
| RESEARCHER/S: | Daniel Alcalá, David Soto |
| PROJECT: | Decoding the neural representation of social concepts |
| CODE: | SOCIALCON |
| DATE: | 17/05/2018 |
| TECHNIQUE: | fMRI |

### FUNDING:

|  |  |  |
| --- | --- | --- |
| Rate hourly by experiment (subject pay included) | | |
| RM | | 500 € |
| MEG | | 500 € |
| EYE TRACKING | | 60 € |
| EEG | | 60 € |
| BEHAVIOUR CABIN | | 25 € |
| BABYLAB | | 25 € |
| Cover by: | BCBL | |
| No. participants | **30**  We estimated n = 30 based on prior MVPA studies here at the BCBL using similar experimental conditions and scanning time. | |
| Session Duration | 2:00 h (90 min scanning and 30 min of filling of consent forms, training, and debriefing) | |
| **Total cost** | € 22,500 | |

### ETHICAL COMMITTEE:

|  |  |
| --- | --- |
| Observations: | |
| **Signature for approval and name of the members of the committee:** |  |
| Committee meeting date: |  |

### SCIENTIFIC COMMITTEE:

|  |  |
| --- | --- |
| Observations: | |
| **Signature for approval and name of the member of the commitee:** |  |
| Committee meeting date: |  |

### **BRIEF DESCRIPTION OF THE EXPERIMENT:** Experiment design (aim, hypothesis, script description, methods, data analysis):

The past decade has witnessed a significant development in our understanding of how the brain represents concrete concepts (e.g. animals or tools). Only recently there has been a similarly growing interest in studying the neural representations of abstract concepts (for a review, see Bauer and Just, in press). For instance, Ghio et al. (2016) showed in an fMRI study that BOLD activity patterns in the inferior frontal gyrus and the insula allow for the identification of abstract as opposed to concrete concepts (e.g. emotional or mathematical vs. action concepts).

The present fMRI study aims at investigating the neural representations of a specific type of abstract concepts that refer to social information. Social concepts differ from other other (nonsocial) abstract concepts in that the relevance for social interactions is heavily influenced by contextual information. For instance, concepts such as ‘trustworthy’ can relate to ourselves, to others, as well as to nonhuman animals or even inanimate objects. While the study of social information processing has traditionally focused on how we perceive faces, voices, body posture, and biological movement (for a review, see Green, Horan, & Lee, 2015), conceptual knowledge about others has received much less attention in the social neuroscience literature. In a recent fMRI study, Wang and others (2017) found that the anterior temporal lobe serves as a hub for a distributed neural circuit that represents information related to people. This is congruent with a previous study showing increased activation in the superior anterior temporal lobe when participants processed social information (Zahn et al., 2007). However, this type of univariate approaches are ill-suited for assessing differences in the neural representations of concepts that are likely to be encoded in distributed patterns of activity.

Most critically, social information involves a range of dimensions, yet it is unknown whether (and how) the brain maps seemingly different aspects of social information. Accordingly, the aim of the proposed fMRI study is to investigate the neural representations of abstract concepts associated with two fundamental processes in social cognition: (i) theory of mind concepts (i.e. concepts that refer to the attribution of mental states to others, such as ‘honest’ or ‘intelligent’); and (ii) social concepts with an affective component related to empathetic states (i.e. ‘cruel’ or ‘caring’). Moreover, it has been shown that neutral concepts to refer to other individuals are scarce, since social concepts are heavily influenced by their likableness (Anderson 1968). Therefore, the present study will examine as well the neural representations of abstract social concepts along the high- vs. low-likableness continuum.

The experiment consists of 8 blocks, each comprising 18 social concept definitions. In each block participants will listen to a series of auditory stimuli that involve short definitions of social concepts (e.g. ‘Sabe razonar, resolver problemas y comprender ideas complejas’). To facilitate semantic access, participants will be instructed to think about the concept definitions and attribute the referred interpersonal attitudes, beliefs, intentions, or emotions to a known person of their own choice (e.g. a family member, an acquaintance, a public figure or famous person, etc.).

A trial begins with the auditory presentation of the definition of a concept, randomly selected from a pool of 18 concepts (9 theory of mind-related and 9 empathy-related). Each definition is presented for a period of 2-3 seconds (s), and is followed by a delay of 3 s. During such delay, participants are asked to think about the concept as previously described. Following the delay, a red asterisk is presented to inform the participant that the trial is over. To ensure that participants attend to the stimuli, each block includes a variable number of catch trials (0, 1 or 2). Here, following the offset of the auditory stimulus, a visual word will be presented and participants will be required to press a button to indicate whether the word matches the defined concept previously presented.

Data will be preprocessed following standard procedures using FSL (ICA-AROMA, high-pass temporal filtering, and 3 mm smoothing). Then, multivariate pattern analyses will be conducted to investigate the brain activity patterns in a set of ROIs consistently reported to be involved in abstract vs. concrete conceptual knowledge processing (i.e. left inferior parietal, anterior temporal, and inferior frontal areas; Binder et al., 2009; Wang et al., 2010; Mayer et al., 2017), and ROIs associated with key nodes of the social network (i.e. anterior insula and dorsal anterior cingulate cortex; Alcalá-López et al., 2017). Of special interest are the posterior cingulate and medial prefrontal areas since these have been identified in univariate analyses to increase activation in tasks involving semantic and social processes (Hyatt et al., 2015).

More specifically, we will use an unbiased feature selection procedure (i.e. PCA) to identify relevant voxels in each ROI. Then, we will use an SVM-based linear classifier to decode: (i) the social nature of the definitions (theory of mind vs. empathy); as well as (ii) their likableness (high vs. low). Classification will be performed within each subject in native space, and decoding accuracy will be obtained for each ROI. We will use a leave-one-out cross-validation procedure in which an SVM classifier will be trained in 90% of the trials and tested in the remaining 10%. This procedure will be repeated 500 times, each time by randomly selecting training and testing sets. Classification accuracies will be obtained for each ROI, individual subject, and condition, with the significance of decoding performance assessed at the group level by means of one-sample t-test.

Although neural activation increases as a response to abstract concepts processing are consistently reported in the IPL, ATL, and IFG, we predict that decoding accuracies of the class of social concept will be greater in the mPFC, PCC, AI, and dACC. Moreover, our design will further allow us to test the influence of the ‘likableness’ factor in the encoding of social information, namely, whether there is a gradient of ‘likableness’ in sub-regions of the above ROIs or whether this dimension of social information is encoded in distributed MVP activity in distinct brain areas. Accordingly, in addition to the hypothesis-driven MVP analyses in our a priori ROIs described above, further exploratory analyses will be conducted using a searchlight approach to assess the decoding of social classes across the whole brain.

Finally, participants will complete a behavioral task outside the scanner in which they will rate the similarity between each pair of social concepts. The resulting psychological similarity matrix will be used in a follow-up exploratory analysis as a template for a searchlight to find brain regions in which psychological similarity of concepts matches corresponding neural activity patterns (indexed by the Pearson correlation among the voxel activity patterns between each pair of concepts within a given sphere in the searchlight analysis).

### PARTICIPANT’S REQUIREMENTS:

|  |
| --- |
| Please indicate all the requirements for your participants (number, native language, age, etc.):  - 30 participants will be recruited in total  - Spanish speakers  - 18-30 years old |

|  |
| --- |
| Please specify any other piece of information that you consider we should know in order to run the experiment:  - Potential participants should wear no glasses (contact lenses is fine though) and must be right-handed. |

### INSTRUCTIONS:

### SPECIAL SETTINGS REQUIRED:

|  |
| --- |
| Please indicate whether the experiment needs of a special setting and detail the equipment and elements that should be obtained to place this setting (devices, software, etc.):  - NONE |

### INFORMATION ABOUT THE TASK:

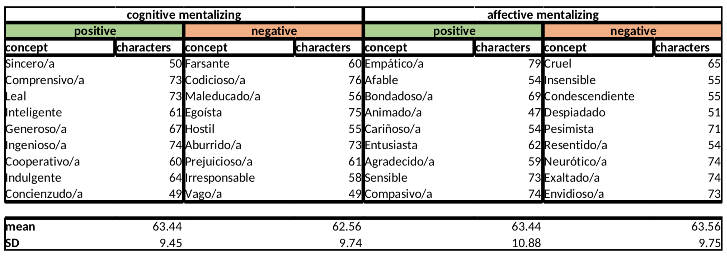
|  |  |  |
| --- | --- | --- |
| Parameters | By default | Selected |
| Sessions number |  | 1 |
| Sessions duration |  | 2:00 h (including filling consents, training, debriefing, etc.) |
| Stimuli Type | Visual / Auditive/ | Auditive |
| Response Type | Manual/Verbal | Manual |
| Devices: | Touch Pad/ Gamepad/ Response Box/ | Response Box |
| Headphone/ Microphone/ |  |
| Program | DMDX/ Matlab/ Presentation/ Experimental Builder | Psychophy |
| Questionnaires | Consent form | YES |
| **Please transcribe as precisely as possible the instructions that should be orally given to the participants. Also any other special requirement for interactions with them that you would want to set in advance:**  En este experimento queremos investigar cómo la actividad del cerebro refleja los conceptos que usamos para pensar acerca de las personas.  El experimento está dividido en 8 bloques, cada uno de aproximadamente 8 minutos. En cada bloque te vamos a presentar una serie de definiciones que describen conceptos que usamos para describir a las personas. Algunas de estas definiciones hacen referencia a las intenciones, las ideas o las actitudes de los demás, mientras que otras definiciones hacen referencia a sus emociones, a cómo se sienten.  En cada bloque, al inicio de un ensayo te aparecerá un asterisco rojo que indica que en ese momento no tienes que hacer nada. Seguidamente, escucharás la definición de un concepto. Tras escuchar la definición, te pedimos que pienses en ese concepto del modo más significativo para ti. Se trate de que prestes mucha atención al significado de las definiciones. Esto es, qué implica el comportamiento referido en la definición, o qué te parece cuando alguien se comporta así. Ademas, también podrías asociarlo con algún personaje famoso, familiar o amigo en una situación en la que se comporta de la forma que describe el concepto que te hemos presentado.  El mismo concepto aparecerá definido varias veces a lo largo del experimento. Cada vez que se te presente, puedes pensar en el de la forma que más te ayude a entender su significado, incluso si te sirve puedes utilizar una estrategia similar a las otras veces que se te ha presentado esa definición.  IMPORTANTE: Siempre que veas el asterisco rojo en la pantalla, por favor trata de mantener tu mente en blanco, no pensar en nada y esperar al siguiente ensayo.  De sorpresa, puede aparecer tras la definición de un concepto una palabra escrita en la pantalla (por ejemplo: ‘EMPÁTICO/A’). En este caso, te pedimos que pulses el botón que te vamos a facilitar si la palabra se corresponde con la definición que acabas de oír.  A continuación te vamos a dar una lista de los conceptos que vas a ver para que los conozcas antes de entrar en el escáner.  Conceptos que se refieren a comportamientos o actitudes  SINCERO/A  COMPRENSIVO/A  LEAL  INTELIGENTE  GENEROSO/A  INGENIOSO/A  COOPERATIVO/A  INDULGENTE  CONCIENZUDO/A  FARSANTE  CODICIOSO/A  MALEDUCADO/A  EGOÍSTA  HOSTIL  ABURRIDO/A  PREJUICIOSO/A  IRRESPONSABLE  VAGO/A | | |
| Conceptos que se refieren a las emociones de los demás  EMPÁTICO/A  AFABLE  BONDADOSO/A  ANIMADO/A  CARIÑOSO/A  ENTUSIASTA  AGRADECIDO/A  SENSIBLE  CRUEL  INSENSIBLE  CONDESCENDIENTE  DESPIADADO/A  PESIMISTA  RESENTIDO/A  NEURÓTICO/A  EXALTADO/A  ENVIDIOSO/A    ¡Gracias por participar! | | |

**Mentalizing about the ideas, beliefs or intentions of others**

|  |  |  |  |
| --- | --- | --- | --- |
| **Concept** | **Likableness** | **Definition** | **Characters** |
| Sincero/a | 1 | "Dice lo que piensa realmente, sin mentir ni fingir". | 50 |
| Comprensivo/a | 3 | "Entiende el porqué del comportamiento de los demás y se muestra tolerante". | 73 |
| Leal | 4 | "Siempre actúa con respeto y fidelidad a sus compromisos o hacia los demás". | 73 |
| Inteligente | 7 | "Sabe razonar, resolver problemas y comprender ideas complejas". | 61 |
| Generoso/a | 24 | "Tiene inclinación a dar y compartir por encima de su propio interés". | 67 |
| Ingenioso/a | 40 | "Tiene capacidad para inventar cosas combinando su inteligencia y habilidad". | 74 |
| Cooperativo/a | 45 | "Disfruta haciendo cosas y combinando esfuerzos con los demás". | 60 |
| Indulgente | 56 | "Tiende a perdonar las ofensas y juzgar sin severidad a los demás". | 64 |
| Concienzudo/a | 65 | "Pone mucha atención y cuidado en todo lo que hace". | 49 |
| Farsante | 2 | "Se hace pasar por alguien que no es para engañar a los demás". | 60 |
| Codicioso/a | 16 | "Siempre intenta acumular más y más cosas, y nunca las comparte con nadie más". | 73 |
| Maleducado/a | 18 | "No tiene buenos modales y habla sin respetar a los demás". | 56 |
| Egoísta | 24 | "No se interesa por el interés de los demás, sólo por su propia conveniencia". | 75 |
| Hostil | 33 | "Tiene una actitud provocativa y abusiva hacia otros". | 55 |
| Aburrido/a | 42 | "Fastidia a los demás con su falta de diversión o de interés por las cosas". | 73 |
| Prejuicioso/a | 56 | "Juzga a los demás en base a opiniones preconcebidas negativas". | 61 |
| Irresponsable | 57 | "No es consciente de sus obligaciones y actúa sin previsión". | 58 |
| Vago/a | 87 | "Nunca lleva a cabo las tareas que debería cumplir". | 69 |

Empathizing with the affective states of others

|  |  |  |  |
| --- | --- | --- | --- |
| **Concept** | **Likableness** | **Definition** | **Characters** |
| Empático/a | 3 | "Se pone en el lugar de los demás y siente en sus propias carnes cómo se sienten". | 79 |
| Afable | 13 | "Su forma de ser demuestra simpatía, sencillez y bondad". | 54 |
| Bondadoso/a | 18 | "Tiende de forma natural a comportarse bien y hacerle bien a los demás". | 69 |
| Animado/a | 29 | "Transmite su carácter alegre, agradable y ameno". | 47 |
| Cariñoso/a | 31 | "Trata con afecto a los demás y desea estar en compañía". | 54 |
| Entusiasta | 51 | "Tiende a emocionarse mucho y con facilidad casi todo el tiempo". | 62 |
| Agradecido/a | 64 | "Valora mucho y se siente muy feliz cuando le hacen un favor". | 59 |
| Sensible | 97 | "Se emociona ante las muestras de sentimientos como el amor o la compasión". | 73 |
| Compasivo/a | 104 | "Se entristece cuando ve padecer a alguien e intenta aliviar su sufrimiento". | 74 |
| Cruel | 4 | "No siente compasión ante el sufrimiento ajeno o se deleita con él". | 65 |
| Insensible | 37 | "Ni se emociona ni percibe los sentimientos de los demás". | 55 |
| Condescendiente | 38 | "Cuando habla hace que los demás se sientan despreciados". | 55 |
| Despiadado | 43 | "No perdona nada a nadie ni muestra compasión alguna". | 51 |
| Pesimista | 97 | "Se desespera porque sólo puede ver el aspecto más negativo de las cosas". | 72 |
| Resentido/a | 115 | "Se comporta como si la vida le maltratara todo el rato ". | 54 |
| Neurótico/a | 118 | "Es muy inestable y reacciona ante las cosas de forma emocional y exagerada". | 74 |
| Exaltado/a | 119 | "Pierde la calma con facilidad y reacciona de forma agresiva ante los demás". | 74 |
| Envidioso/a | 131 | "Se siente triste o enfadado/a cuando no tiene lo mismo que otras personas". | 73 |



**SETTINGS BY TECHNIQUE: PLEASE COMPLETE AS APPROPRIATE**

### **RM SETTINGS:** This will be the same used in our prior MVPA study at BCBL entitled ‘Metasema’

Only the number of TRs will be changed.

|  |  |
| --- | --- |
| Abbreviation:  L: Localizer  F: Functional  S1: Structural T1  D: Diffusion  S2: Structural T2  PO: Pause with volunteer outside of the machine  PI: Pause with volunteer inside of the machine  O: Other  /: When there are two sessions or more in different days | Example:  L,FFF,S1-PO-L,FFF,D  In this example, two consecutive sessions in which volunteer will go out of the machine. First session, three functional sequences and one structural sequence. Second session, three functional sequences and one diffusion sequence. |
| Please indicate your sequence order description:  \*Please fill all the parameters in the enclosed tables |  |

|  |  |  |  |
| --- | --- | --- | --- |
| Structural T1: High –resolution structural MRI T1 3D | | | |
| Parameters | By default | Selected | Experiment running properties: Order, experiment list, name |
| TE/TR/Flip Angle | 2.97ms/2530ms/7deg |  |
| Slices/Slice thickness/GAP | 176/1mm/50% |  |
| FOV/Matrix | 256/256\*256 |  |  |
| Slice order/Orientation | Ascending/transversal |  |
| Type: | 3D |  |
| Other: |  | |

|  |  |  |  |
| --- | --- | --- | --- |
| Functional : Standard EPI sequence for FMRI without movement correction 2D | | | |
| Parameters | By default | Selected | Experiment running properties: Order, experiment list, name |
| TE/TR/Flip Angle | 30ms/2000ms/78deg |  |
| Slices/Slice thickness/GAP | 32/3mm/25% |  |
| FOV/Matrix | 192/64\*64 |  |  |
| Slice order/Orientation | Descending/transversal |  |
| Scans number, volumes or dynamics |  |  |
| Other: |  | |

|  |  |  |  |
| --- | --- | --- | --- |
| Functional : Standard EPI sequence for FMRI without movement correction 2D | | | |
| Parameters | By default | Selected | Experiment running properties: Order, experiment list, name |
| TE/TR/Flip Angle | 30ms/2000ms/78deg |  |
| Slices/Slice thickness/GAP | 32/3mm/25% |  |
| FOV/Matrix | 192/64\*64 |  |  |
| Slice order/Orientation | Descending/transversal |  |
| Scans number, volumes or dynamics |  |  |
| Other: |  | |

|  |  |  |  |
| --- | --- | --- | --- |
| Functional : Standard EPI sequence for FMRI without movement correction 2D | | | |
| Parameters | By default | Selected | Experiment running properties: Order, experiment list, name |
| TE/TR/Flip Angle | 30ms/2000ms/78deg |  |
| Slices/Slice thickness/GAP | 32/3mm/25% |  |
| FOV/Matrix | 192/64\*64 |  |  |
| Slice order/Orientation | Descending/transversal |  |
| Scans number, volumes or dynamics |  |  |
| Other: |  | |

|  |  |  |  |
| --- | --- | --- | --- |
| DTI: | | | |
| Parameters | By default | Selected | Experiment running properties: Order, experiment list, name |
| Diff directions/TE/TR | 64/99ms/9300ms |  |
| Slices/Slice thickness/GAP | 58/1.8mm/0% |  |
| FOV/Matrix | 230mm/256\*256 |  |  |
| Slice order/Orientation | Intercalated/transversal |  |
| bo/b (s/mm2) | 0/1500 |  |
| Other: |  | |

|  |  |
| --- | --- |
| Others | |
| Parameters | Experiment running properties: Order, experiment list, name |
|  |  |

### LAB FACILITIES AND HUMAN RESOURCES

|  |
| --- |
| **When and who is going to run your experiment?\***  **Preferably**  During the Lab Hours and by the lab staff **(to help us out with 10 participants within lab hours)**  During the Lab Hours and by the researcher or someone of his/her group  **But also**  Out of Lab Hours and by the researcher or someone of this/her group  **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**  \* *Predocs and Master Students should run their own experiments. If they don’t speak Basque or Spanish and it is required in the experiment please contact the Lab Managers.*  *\*\* Only in special population’s experiments. Contact Manuel Carreiras, Miguel Arocena or Lab Managers.* |

|  |
| --- |
| **HELP IN PREPROCESSING the Images/Audios**  Will you need lab assistance to Preprocess the Images/Audios?  NO. The lab has already helped us to prepare the audio stimuli for the experiment. |

### **FEEDBACK FOR THE PARTICIPANTS** Write down if you wish to feedback the participants with any relevant information about the current experiment once they finish the experiment. For example, *the hypothesis, simple article/reviews, mini-poster…*

*En este estudio tratamos de investigar cómo el cerebro procesa el significado de conceptos abstractos.*

*Usamos los datos de resonancia para construir un modelo que nos permite conocer cómo procesa el cerebro los conceptos que usamos habitualmente para referirnos a otras personas.*

*Hasta ahora sabemos que existen diferentes zonas del cerebro que se encargan de procesar el significado de palabras concretas (por ejemplo, categorías como animales o herramientas). Lo que queremos hacer es utilizar estos modelos para ver si ocurre lo mismo con conceptos más abstractos, o si el cerebro procesa este tipo de información de otra manera. A través de los datos de resonancia, podemos llegar a saber con mayor precisión cómo el cerebro procesa cualquier tipo de significado y poder llegar así a saber lo que uno está pensando, con qué viveza, o si puede haber algún déficit a la hora de procesar el significado de algunos conceptos.*

*Una vez que tengamos buenos modelos sobre cómo nuestro cerebro procesa el significado de las cosas, podremos aplicar este conocimiento para evaluar y diagnosticar mejor los trastornos de aprendizaje que ocurren en niños y también otros trastornos relacionados durante el envejecimiento.*

### FEEDBACK FOR THE RESEARCH ASSISTANTS AND COORDINATORS

Is there any other information or article that you think that it is related to your experiment and that would be interesting for the lab staff?

A nice review of fMRI studies using multi-voxel pattern analysis and machine learning to study how the brain represents concepts can be found here:

[http://www.ccbi.cmu.edu/reprints/Bauer\_Just\_Oxford-Handbook\_chapter%2021\_CCBI-preprint.pdf](http://www.ccbi.cmu.edu/reprints/Bauer_Just_Oxford-Handbook_chapter%252021_CCBI-preprint.pdf)